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PREDICTION OF OPTIMAL TORQUES FROM GAIT ANALYSIS APPLYING THE MACHINE LEARNING CONCEPTS

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ABSTRACT

With the advancements in engineering and technology and with the advent of the fourth industrial revolution made the solution for complex and dynamic problems easier. Many researchers had incredibly investigated about the problems, which are outcomes of prosthetic leg, attached to a human being especially at working conditions and still the problem pertains till date. This might be one of the crisp reasons which insisted& necessitated to undergo this project. In this project, considering a set of persons aging 19-28 were made to walk on a tread mill. It is a tedious process to take the hip and knee angles physically using various sensors and its very complicated process to generate torque values and finding the optimal torque values for different persons converting physical variables to digital variables. To overcome this problem advanced software's like Kinovea is employed for measurement of angular cycles for gait analysis and based on these values machine learning algorithm is employed to find the accuracy and better prediction of torques for different disabled persons.

KEYWORDS: Frames per second (fps), Gait Analysis, Multivariable Linear Regression (MLR) & Root Mean Square Error (RMS)

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Original Article

1. INTRODUCTION

In early 1990's it was very difficult to measure the hip angle as well as the knee angle of a specially abled person because there it needed a physical mounting of sensor on the amputee to calculate the knee angle as well as hip angle for different speeds and different walking cycles [1][2]. Though the employability of dart fish sensors as well as required values, still there is an uncertainty about mounting of sensors and calibration of sensors in measuring the angular ankle cycles. Gait analysis for these values for an amputee is not that accurate and ergonomical, these constraints had made a huge necessity to go far advanced software's like kinovea which works on video motion analysis [3][4]. Kinovea is best among the present available motion analysis software's for capturing real time values at every instant of time and it is available in open source [5]. Generally in the case of developing nations like India and many other countries having the huge demand of exoskeleton for specially disabled amputees for various reasons like accidents and genetic problems, based on current population and increasing number of exoskeletons in the field of transfemoral prosthetics. It necessitated for cost optimization as well as better efficient and accurate test result values from various sources. Employing automation that is highly accurate and strong, efficient in programming and deriving outputs makes a difference. With the rapid growth of

industrial revolutions the latest software's like python is used for reducing the complexity of problem, by easing the mathematical empirical calculations for measuring maximum cycles. Later on including the methodologies of machine learning procedures gives better accuracy and efficient results for designing and developing exoskeletons in more ergonomical & efficient manner.

In present world populating more than 7 billion persons around the globe, more than 17 to 20% in a billion of them were in the need of prosthetics and exoskeletons for various reasons like aging, amputing because of accidents, severe illness and physical stress. For procuring gait analysis needs calculation of torque values by using Lagrangian Euler formulation, one of the best methods of analysing and computing the complex structure and the behaviour of serial link chain which is efficiently done by Lagrangian equation, this method provides easier way of solution.

2. METHODOLOGY

This paper depicts mainly on the prediction of output torques for the gait cycle that has to be performed to the amputee using machine learning techniques. In this paper, the torque governing equation is derived from the Lagrangian mathematical model. Various independent inputs like height, mass, weight of the amputee is obtained through video motion analysis. Acquired data is processed using advanced computational software and the prediction of torques can be obtained by employing machine learning algorithms. This has been pictorially represented with the flow chart that describes the series of steps that has to be performed to obtain the output torques for amputees.

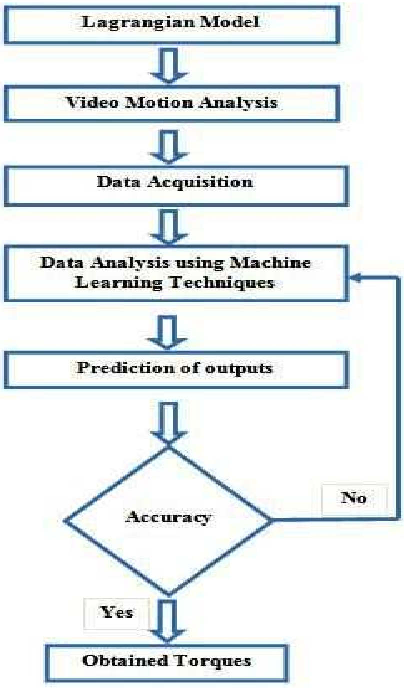


Figure 1: Flow Chart for Prediction of Torques

2.1 Lagrangian Model

Lagrangian equation is mainly based on generalized forces, as well generalized coordinates are defined as the angles and distances considered for revolute, prismatic joints [6]. The torques or forces that were associated with the joint actuators were calculated using generalized forces. In general terms for a physical system the total number of generalized coordinates are considered, calculated depending on the position of the mass of degrees of freedom. This modelling

technique is based on the lumped parameter model with internal components of point masses which are located at centre of gravity of the generalized links. The Lagrangian function is represented with 'L' and is defined as the difference between kinetic energy (K) and potential energy (P) of a system.

$$L = K - P \tag{2.1}$$

The Lagrangian Euler formulation is described with a set of system variables. For the generalized displacement 'q' for a joint variable the Lagrangian Euler formulation is obtained by

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}i}\right) - \frac{\partial L}{\partial \dot{q}i} = \tau_i;\ \text{fori} = 1, 2, \text{-------}n \tag{2.2}$$

For the condition $\boldsymbol{\tau_i = 0}$, states that joint **'i'** is static whereas $\boldsymbol{\tau_i \neq 0}$, the system is dynamic and is modified at various instance of time.

For a human leg, the degrees of freedom are mainly dependent on two functional parameters i.e knee joint and hip joint. Hence the system is of 2 DOF and it requires two torque governing equations to be calculated.

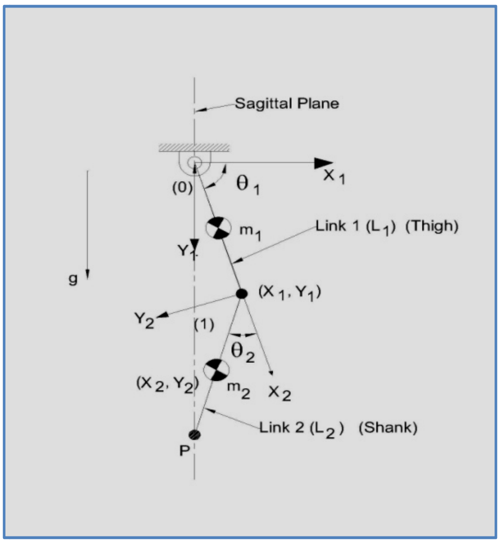


Figure 2: Lagrangian Model for 2-DOF System

The joint variables were represented as θ_1, θ_2 and link lengths were represented as L_1 and L_2 mass of the links were represented as m1 and m2 respectively. The linear velocities were represented as v_1 and v_2, angular velocities are represented $\dot{\theta}_1$,$\dot{\theta}_2$ respectively. For link 1, substituting and generalizing all the process variables the kinetic energy of link 1 is obtained as

$$K_1 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}I_1\omega_1^2 = \frac{1}{8}m_1L_1^2\dot{\theta}_1^2 + \frac{1}{24}m_1L_1^2\dot{\theta}_1^2 = \frac{1}{6}m_1L_1^2\dot{\theta}_1^2 \tag{2.3}$$

The potential energy for link (1) is given as

$$P_1 = \frac{1}{2}m_1gL_1\sin\theta_1 \tag{2.4}$$

Considering link (2), the Cartesian coordinate position values(x_2, y_2) are given as

$$x_2 = L_1\cos\theta_1 + \frac{1}{2}L_2\cos(\theta_1+\theta_2)` \tag{2.5}$$

$$y_2 = L_1\sin\theta_1 + \frac{1}{2}L_2\sin(\theta_1+\theta_2) \tag{2.6}$$

Differentiating those equations and simplifying the magnitudes of velocities of link 2, the final kinematic equation is obtained as

$$K_2 = \frac{1}{2}m_2v_2 + \frac{1}{2}I_2\omega_2^2 \tag{2.7}$$

The potential energy for link 2 is obtained as

$$P_2 = m_2gL_1S_1 + \frac{1}{2}m_2gL_2S_{12} \tag{2.8}$$

By substituting the kinematic as well as potential energy the torque equation for link (1) is derived as:

$$\tau_1 = [(\frac{1}{3}m_1+m_2)L_1^2+\frac{1}{3}m_2L_2^2+m2L_1L_2C_2]\ddot{\theta}_1+m_2[\frac{1}{3}L_2^2+\frac{1}{2}L_1L_2C_2]\ddot{\theta}_2-m_2L_1L_2S_2\dot{\theta}_1\dot{\theta}_2-\frac{1}{2}m_2L_1L_2S_2\dot{\theta}_2^2+(\frac{1}{2}m_1+m_2)gL1C1+\frac{1}{2}m_2gL_2C_{12} \tag{2.9}$$

Similarly for link (2) the governing torque equation is derived as

$$\tau_2 = m_2[\frac{1}{3}L_2^2+\frac{1}{2}L1L2C2]\ddot{\theta}_1+\frac{1}{3}m2L_2^2\ddot{\theta}_2+\frac{1}{2}m_2L_1L_2S_2\dot{\theta}_1^2+\frac{1}{2}m_2gL_2C_{12} \tag{2.10}$$

From (2.9), (2.10) governing equations the empirical relation for finding the torque values for a 2 DOF prosthetic system is given as:

$$\begin{bmatrix}\tau_1\\ \tau_2\end{bmatrix} = \begin{pmatrix} m_1l_1^2(\frac{5}{3}+C_2) & m_1l_1^2(\frac{1}{3}+\frac{1}{2}C_2) \\ m_2l_2^2(\frac{1}{3}+\frac{1}{2}C_2) & \frac{1}{3}m_2l_2^2 \end{pmatrix}\begin{bmatrix}\ddot{\theta}1\\ \ddot{\theta}2\end{bmatrix} + \begin{bmatrix} -m_1l_1^2S_2\theta_1'\theta_2' - \frac{1}{2}m_1l_1^2S_2\dot{\theta}_2^2 \\ \frac{1}{2}m_2l_2^2S_2\dot{\theta}_1^2\end{bmatrix} + \begin{bmatrix}\frac{1}{2}m_1gl_1C_{12}+\frac{3}{2}m_1gl_1C_1 \\ \frac{1}{2}m_2gl_2C_{12}\end{bmatrix} \tag{2.11}$$

2.2 Kinovea

Mounting of physical sensors on the amputees for obtaining gait analysis and finding torque values is never been that easy. To overcome this problem, with the advancements in the field of engineering and technology simulation software's were employed, which performs objectification of human movements. Kinovea is the best open source software which is a low cost technology that enables motion analysis for 2D kinematics parameters. Kinovea software enables the user to analyze the movement of any subject, calculation of displacement and mainly employed in calculating gait analysis [7]. Kinovea enables the analysis of angles and spatiotemporal parameters. It enables the user to measure angles and distances with respect to frames. It has high reliability in measuring hip, knee and ankle measurement values with different velocities with respect to time. Kinovea employs point tracking function which enables to obtain data without any training of the data to system, which is reliable and efficient. Kinovea is easy to use as well as portable and highly accurate in obtaining kinematics data in real time scenario. It employs image capturing procedures, frames calibration, image digitalization and finally exporting of data to spread sheet by data extraction and transformation techniques for statistical analysis of gait cycle. In this research kinovea 0.8.15 version, which is an open source downloadable format for any operating system is used.

2.3 Machine Learning

Machine learning is the process where a computer can learn themselves from the data provided as input by the process of continuous training and testing and making the system intelligent[8]. With the help of machine learning concepts, there is no necessity of explicit programming for the huge amount of data and the tasks that are to be programmed in the earlier cases [9]. The performance of machine learning is measured in terms of accuracy of the algorithms in the process.

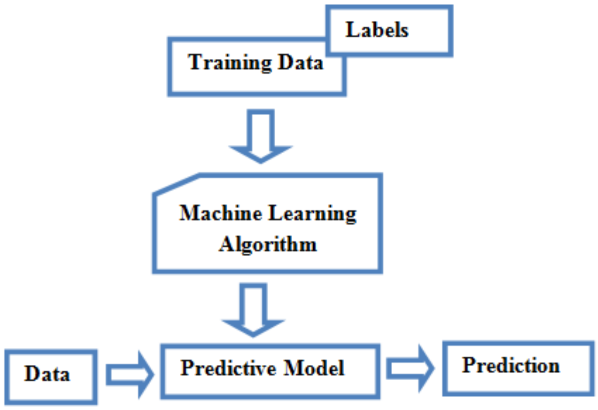


Figure 3: Machine Learning Block Diagram

The learning concepts in machine learning are broadly classified as 4 types. They are:

- Supervised learning.
- Un-supervised learning.
- Semi-supervised learning.
- Reinforcement learning.

In this paper by employing supervised learning process the required output data is generated. According to the inputs the best suitable algorithm for processing the data for testing and training conditions is multiple linear regression. For programming in machine learning, opted python script, as python is one of the best open source software which is available in market and is having high performance and strong programmability of machine learning concepts. Employing spyder, cross platform integrated development environment for scientific programming language python which is open source IDE tool, available in anaconda navigator app. By downloading anaconda navigator app and launching the spyder software, programmed the given sets of input training data using multiple linear regression algorithm.

3. DISCUSSION & COMPUTATIONAL ANALYSIS

Experimental Setup

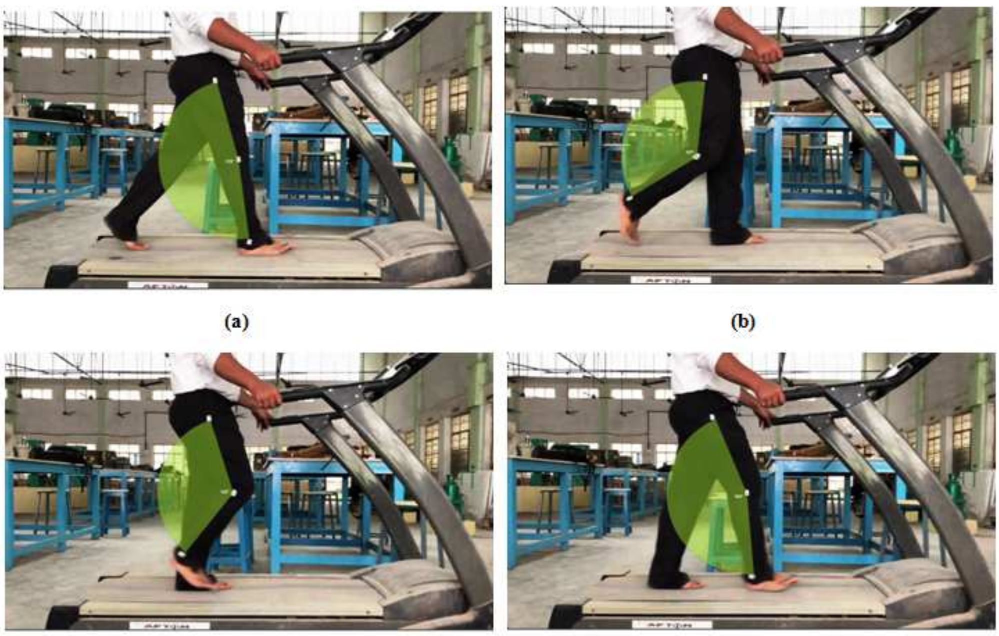
The data has been collected from 50 healthy student's age ranging from 19-28 years of age [10]. The persons were not prone or subjected to any injuries and abnormalities. The data was collected from the persons during a study state controlled speed at 2 km/hr on a treadmill using video motion analysis using kinovea[11]. The lens opted for coupling the data during the steady state controlled walking speed is Sony F57 E-mount 28-135mm F4 cineservo 180frames/sec(fps) with the shutter speed 1/200 s, distanced at 3.5mt from the treadmill and recorded the walking stances of the person. Three

colour node indicators were attached to the hip, knee and ankle to calculate the respective angle measurements. The recorded data is for the duration of one minute and fps is at the rate of 60 fps.

Figure 4: Experimental Setup on a Treadmill

3.2 Data Retrieving

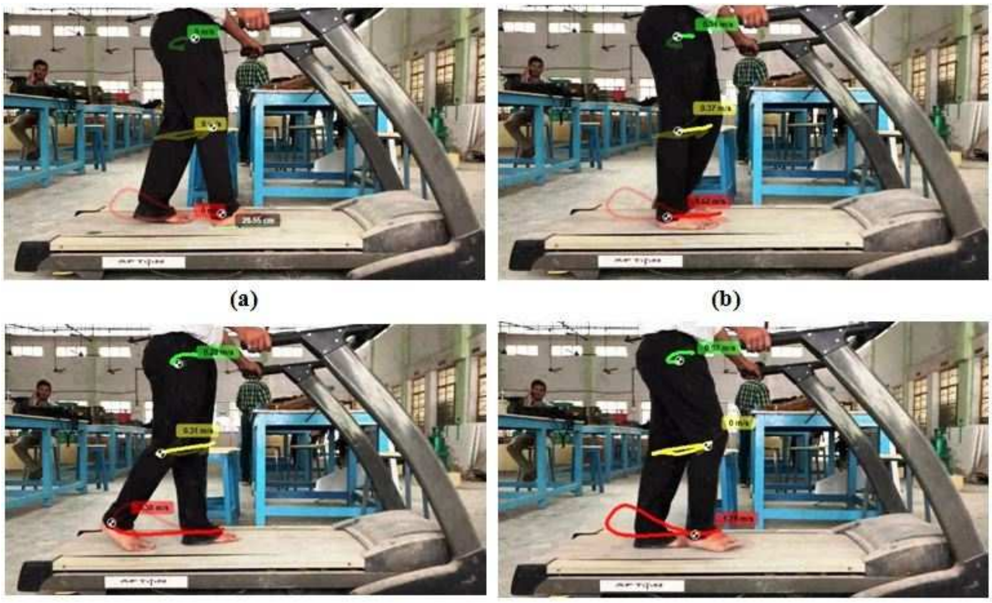
The captured data is calibrated for one complete cycle which includes gait cycle i.e. stance phase and swing phase and recorded the values with reference to the colour strips perpendicular to the sagittal plane axis and tabulated the values hip, knee with respect to the angle [12]. This process is carried out by loading the video content to kinovea software by which motion analysis happens and accurate results were obtained. Basically the uploaded video content for duration 60 seconds is calibrated to the time taken for a person to complete one gait cycle. This procedure is repeated for 3 cycles from the same subject for the gait analysis by considering 78 fps for one gait cycle and tabulated hip, knee angles [13]. The same sequence of steps has been performed for 50 different subjects of different age groups heights weights and noted down the respective values.



(a) (b)

(c) (d)

Figure 5: Hip & Knee Angle Measurement in Kinovea (A) Heel Strike, (B) Toe Off, (C) Mid Swing, (D) Heel Strike



(a) (b)

(c) (d)

Figure 6: Linear Velocity Measurement in Kinovea (a) Heel Strike, (b) Midstance, (c) Toe Off, (d) Mid Swing

That recorded values has been grafted from spread sheet with provision provided by the kinovea software, which made tabulation of values simpler. The data which is retrieved from kinovea software is the source for obtaining torque values from the Lagrangian Euler model. The data obtained through kinovea are

3.2.1 Hip & Knee Angle (Rad)

Hip and knee angle data is obtained through kinovea by direct subject measurement, i.e., the reference point is taken from the strip attached to the hip of the subject (person) with respect to sagittal plane at different instances of time, by this hip angle(θ_1) data is obtained similarly the knee angle data is obtained by taking the reference point from the strip attached on the knee of the subject (person) with respect to sagittal plane at different instances of time, by this knee angle(θ_2) data is obtained and recorded.

3.2.2 Hip & Knee Angular Velocity (Rad/Sec)

Hip angular velocity ($\dot{\theta}_1$) data is obtained by differentiating the values of hip angle (θ_1) with respect to time. Knee angular velocity ($\dot{\theta}_2$) is processed by differentiating the data of knee angle (θ_2) with respect to time.

3.2.3 Hip & Knee Angular Acceleration (Rad/Sec^2)

Hip angular acceleration ($\ddot{\theta}_1$) is calculated by differentiating the values of hip angular velocity ($\dot{\theta}_1$) with respect to time. Similarly knee angular acceleration ($\ddot{\theta}_2$) is obtained by differentiating the data of knee angular velocity ($\dot{\theta}_2$) with respect to time.

The data tabulated from above values has been normalised and represented in the form of graphical canonical form below

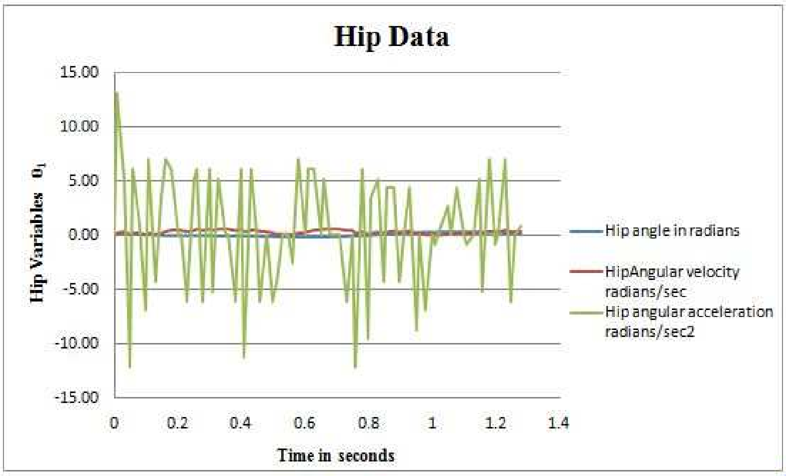


Figure 7: Depiction of Hip Angle, Hip Angular Velocity, Hip Angular Acceleration

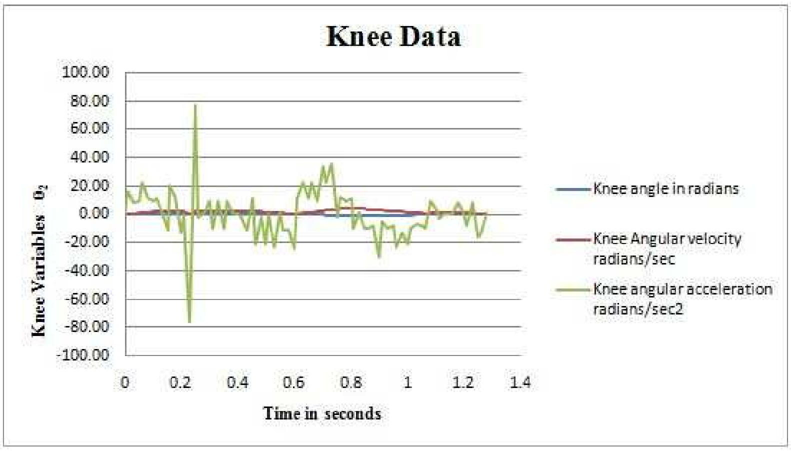


Figure 8: Depiction of Knee Angle, Knee Angular Velocity, Knee Angular Acceleration

3.3 Data Processing

The data obtained from kinovea software through spreadsheets is been tabulated for measurement of hip and knee angles of different aged persons of different mass and heights. The calculation procedure for obtaining the torque of the motor that has to be employed in the prosthetic is very complex and time consuming as well as error prone [14]. The calculation procedure of final torque involves the substitution of values obtained from kinovea software are hip angle, knee angle, linear velocity at hip and knee with respect to time. Along with these values, mass of thigh (m_1), mass of shank (m_2), length of link l_1(thigh), length of link l_2 (shank) and θ_1 ,θ_2 ,

$\dot{\theta}_1$,$\dot{\theta}_2$,$\ddot{\theta}_1$, $\ddot{\theta}_2$ are calculated

Where θ_1 ,θ_2 = angular displacement of first and second link

$\dot{\theta}_1$,$\dot{\theta}_2$ = angular velocity of first and second link

$\ddot{\theta}_1$, $\ddot{\theta}_2$ = angular acceleration of first and second link

$\theta_{12} = \theta_1 + \theta_2$, $S_1=\sin\theta_1$, $S_2=\sin\theta_2$, $S_{12}=\sin\theta_{12}$, $C_1=\cos\theta_1$, $C_2=\cos\theta_2$ and $C_{12}=\cos\theta_{12}$

$$\begin{bmatrix}\tau_1\\ \tau_2\end{bmatrix} = \begin{pmatrix} m_1 l_1^2\left(\frac{5}{3}+C_2\right) & m_1 l_1^2\left(\frac{1}{3}+\frac{1}{2}C_2\right) \\ m_2 l_2^2\left(\frac{1}{3}+\frac{1}{2}C_2\right) & \frac{1}{3}m_2 l_2^2 \end{pmatrix}\begin{bmatrix}\ddot{\theta}1\\ \ddot{\theta}2\end{bmatrix} + \begin{bmatrix} -m_1 l_1^2 S_2 \theta_1' \theta_2' - \frac{1}{2} m_1 l_1^2 S_2 \dot{\theta}_2^2 \\ \frac{1}{2} m_2 l_2^2 S_2 \dot{\theta}_1^2 \end{bmatrix} + \begin{bmatrix} \frac{1}{2} m_1 g l_1 C_{12} + \frac{3}{2} m_1 g l_1 C_1 \\ \frac{1}{2} m_2 g l_2 C_{12} \end{bmatrix}$$

This whole procedure is cumbersome, complex and there is a chance of occurring of error while calculating the final torques.

This procedure has to be perform for 50 persons for different parameters at the rate of 72 values. This procedure has to be repeated for 3 cycles. So in order to overcome this, employed the strongest simulation tool which can perform this whole complex structure and gives accurate results, that software is python, available in open source cross platform IDE and calculated the output torque values. Employing special packages in python like numpy and math libraries eased finding the output torque values.

3.4 Multiple Regression

The main significance of multiple regression algorithm is to get the relationship between inputs and output where the inputs are having more number of independent variables and only one dependent output variable. For this research, having independent variables like age, heights and weights which are multiple in numbers and the output dependent variable, what has to be obtained is torque. As it was nearly impossible to calculate the output torque with respective multiple number of independent input variables, employed multiple linear regression technique and formulated the output torque with respect to input values [15][16].

Considering the multiple linear regression model having independent predictor variable ‘X’ $X=(x_1, x_2, x_3\ldots x_n)$ and dependent output variable ‘y’ is given as

$$y = \beta_0+\beta_1 x_1+\ldots\beta_x x_k+\epsilon \tag{3.1}$$

For ‘i’ number of iterations y_i is given by

$$yi = \beta_0+\beta_1 x_{i1}+\ldots+\beta_x x_{ik}+ \epsilon_i \text{where } i= 1,2,3\ldots n \tag{3.2}$$

The sum of residual square errors is given by

$$\sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (yi-\beta_0-\sum_{j=1}^{k} \beta_i x_{ij})^2 \tag{3.3}$$

That is more simplified as

$$\sum_{i=1}^{n} \epsilon_i^2 = \epsilon^1\epsilon =(y-X\beta)^1(y-X\beta) \tag{3.4}$$

The multiple linear regression technique employed the importing of numpy and pandas packages which are inbuilt and available in python source module spyder from anaconda app, by downloading anaconda navigator and installing spyder software imported the data in the acceptable format for data processing through numpy and pandas. The main importance of numpy is to calculate and predict the output values from the huge data sets that data has been imported in the form of data frames for processing in pandas. This has a very significant and promising role in machine learning and deep learning techniques. Employing a special graphic library i.e. matplotlib helps in plotting the values after processing of the dataset shown in figures (9),(10). A special package namely scikit-learn is employed for performing pre-processing tasks

like transformation of input data, standardizing of data for regression and classification operations [17][18]. By using python script prediction operation using multiple linear regression algorithm is done and torque values were calculated as well as predicted from the input data.

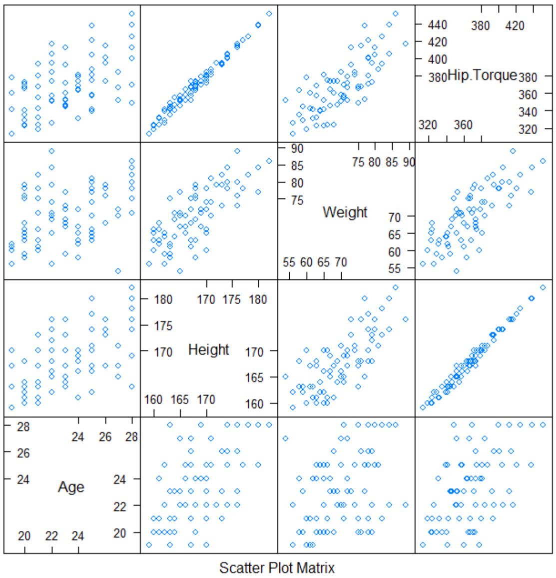


Figure 9: Scatter Plot for Age, Height, Weight and Hip-Torque Weight

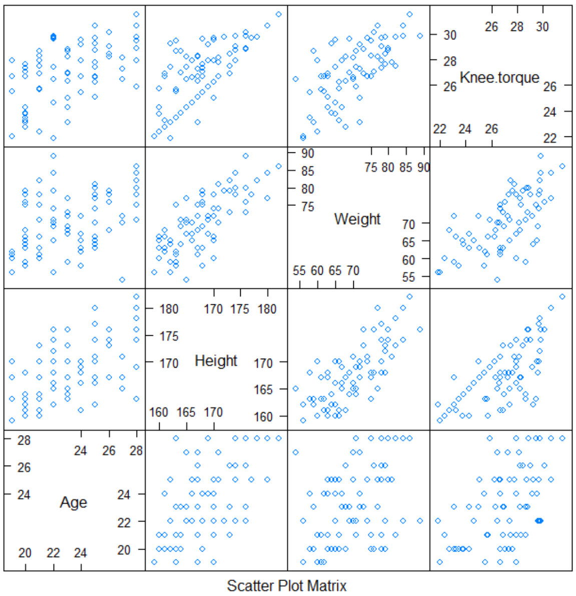


Figure 10: Scatter Plot for Age, Height, and Knee Torque

Accuracy

The predicted output value from multiple linear regression has to be validated by the standard means of calculating the error [19]. For this root mean square error method to be performed has a unique reason, imbibing RMS method, the accuracy of the machine learning algorithm to measure the difference between the predicted values and the actual values can be obtained using the equation (3.5), calculation of rms value for the output test and predicted cycles is tabulated. That rms value has been compared with the output predicted value and the error rate is ±4.069 for the predicted hip torque and ±1.496 for the knee torque shown in figures (11), (12).

$$\text{RMS} = \sqrt{\frac{1}{2}\sum_{i=1}^{n} (y_i\text{-}\hat{y})^2} \tag{3.5}$$

n = number of test data elements (01, 2 ...n)

y_i = Actual value

$\hat{y}$ = Predicted value

Name	Type	Size	Value
dataset	DataFrame	(72, 4)	Column names: Age, Height, Weight, Hip
p	float64	(1,)	[391.52007388]
r	int32	(1, 3)	[[22 172 78]]
rms	float	1	4.060961746063545
y	float64	(72,)	[331.4007888 399.5123687 363.3747946 ... 412.4520137 425.3… 438. ...
y_pred	float64	(29,)	[351.5140865 358.66820417 363.38816012 ... 352.14526877 345.36061367 ...
y_test	float64	(29,)	[346.1433163 359.7943807 373.8524167 ... 350.3762925 348.6… 368. ...
y_train	float64	(43,)	[379.4603331 313.3116432 322.6175127 ... 368.7366408 425.3…

Figure 11: Rms Error Value for Hip Torque Prediction

Name	Type	Size	Value
X_train	int64	(43, 3)	[[24 169 72] [19 159 56]
dataset	DataFrame	(72, 4)	Column names: Age, Height in CM, Weight in kgs, Max Knee torque in N-m ...
p	float64	(1,)	[28.20714988]
r	int32	(1, 3)	[[22 172 78]]
rms	float	1	1.4968574245784856
y	float64	(72,)	[26.66682785 27.95142051 25.457813 ... 28.84314676 29.73… 30.6 ...
y_pred	float64	(29,)	[26.1468748 25.27379662 27.08900749 ... 26.25491534 27.37… 26.9 ...
y_test	float64	(29,)	[24.2677474 26.69505418 28.24980942 ... 26.46608286 29.47…

Figure 12: Rms Error Value for Knee Torque Prediction

4. RESULTS & CONCLUSIONS

The results obtained through machine learning technique by employing the multiple linear regression algorithm is been recorded. The predicted output torque values obtained after processing of data sets by python script through spyder software is shown in figure below.

Name	Type	Size	Value
dataset	DataFrame	(72, 4)	Column names: Age, Height, Weight, Hip
p	float64	(1,)	[391.52007388]
r	int32	(1, 3)	[[22 172 78]]
rms	float	1	4.060961746063545
y	float64	(72,)	[331.4007888 399.5123687 363.3747946 ... 412.4520137 425.3… 438. ...
y_pred	float64	(29,)	[351.5140865 358.66820417 363.38816012 ... 352.14526877 345.36061367 ...
y_test	float64	(29,)	[346.1433163 359.7943807 373.8524167 ... 350.3762925 348.6… 368. ...
y_train	float64	(43,)	[379.4603331 313.3116432 322.6175127 ... 368.7366408 425.3…

Figure 13: Predicted Hip Torque

Name	Type	Size	Value
X_train	int64	(43, 3)	[[24 169 72] [19 159 56]
dataset	DataFrame	(72, 4)	Column names: Age, Height in CM, Weight in kgs, Max Knee torque in N-m ...
p	float64	(1,)	[28.20714988]
r	int32	(1, 3)	[[22 172 78]]
rms	float	1	1.4968574245784856
y	float64	(72,)	[26.66682785 27.95142051 25.457813 ... 28.84314676 29.73… 30.6 ...
y_pred	float64	(29,)	[26.1468748 25.27379662 27.08900749 ... 26.25491534 27.37… 26.9 ...
y_test	float64	(29,)	[24.2677474 26.69505418 28.24980942 ... 26.46608286 29.47…

Figure 14: Predicted Knee Torque

New data set with three different values of age, height, weight of a person respectively were fetched, the data that is considered for the prediction isn't been recorded in the tests and trained data set model. With the help of multiple linear regression algorithm the predicted output torque for the given is of having tolerance ±4.069 and ±1.496 values of the original calculated value. The data obtained from kinovea is compared with the previous methods of data retrieving processes. The data when compared is more or less similar to the previous methods and hence the processing of that data by machine learning algorithm and the prediction of the torques were said to be accurate and hence this method is recommended for prediction and calculation of torque values through gait analysis. This paper shows that the output predicted torque values were almost equivalent to theoretical calculations. This method reduces the complexity of finding torque values from the gait cycle and reduced the redundancy of output values this implies that by formulating and taking the same procedural steps can be used for obtaining torque values for a person who needs transfemoral gait analysis and the amputees for better output processing of torque which indeed helps in selection of appropriate motor in prosthetics.

5. FUTURE SCOPE

With the advancements in science and technology by industrial revolution 4.0, there could be development in much more efficient video motion capturing analysis software's, which intend helps in data capturing and retrieving process. The emerging growth and development in the fields of deep learning concepts could increase the development and enhancement of better algorithms, optimizing functions for prediction of values with minimum average loss in testing and training data sets. This helps a lot in mere future for better prediction and generating best outputs for the given data. All these techniques put together helps in determination of torque values in better way by employing data science concepts.

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